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EVALUATION OF UREA, BORAX, AND SODIUM NITRITE FOR ANNOSUS ROOT ROT PREVENTION IN NEW ENGLAND

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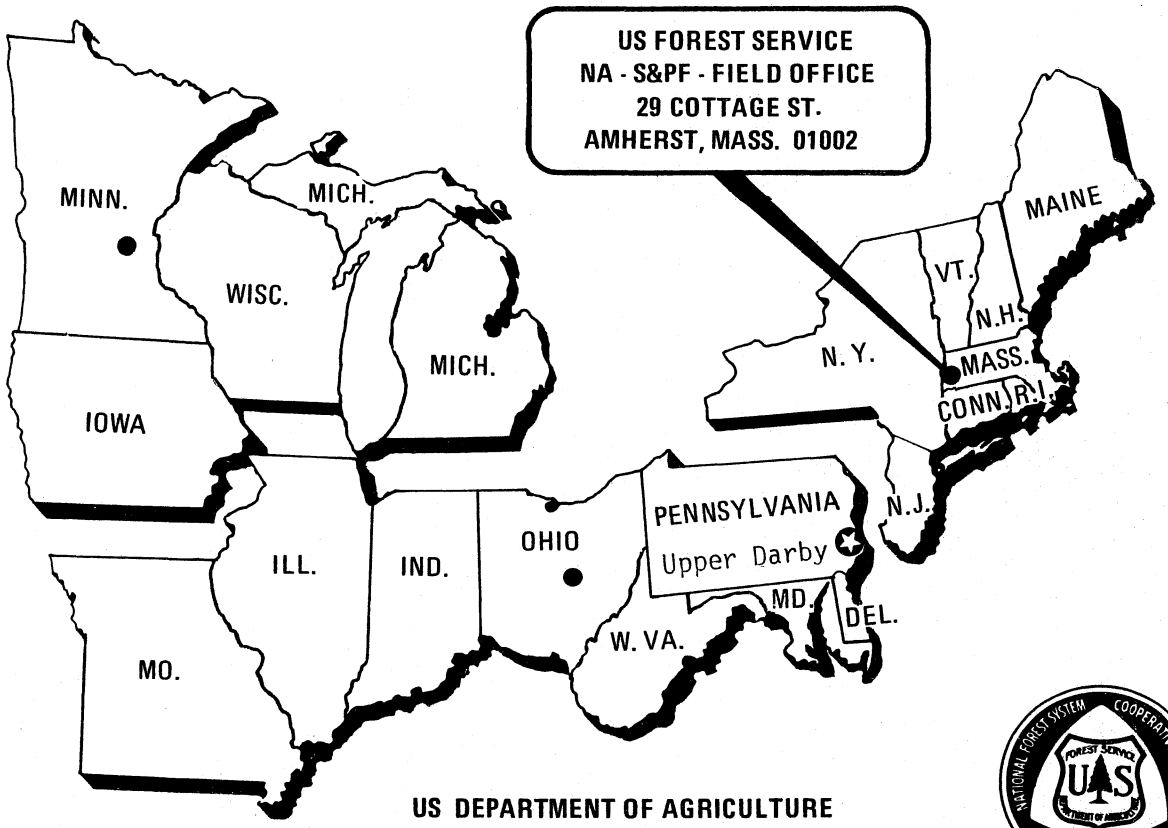

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Brattleboro Municipal Forest and Vermont Department of Forests and Parks, Vermont.

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ABSTRACT

Borax, urea, and sodium nitrite were evaluated for preventing Fomes annosus colonization of the red pine stumps in Rhode Island, Connecticut and Vermont. Borax was the most effective material; 1.3% of the stumps treated with borax, 8.7% of the urea treated stumps and 70% of the sodium nitrite stumps were colonized by F. annosus.

INTRODUCTION

Annosus root and butt rot, caused by Fomes annosus is and will continue to be a major threat to the success of the thousands of acres of coniferous plantations in the Northeast. Many of these plantations are currently being thinned. It has been demonstrated that thinning greatly increases the likelihood of F. annosus infections in stands. Fortunately, means for preventing annosus root rot entrance into these stands are available. The most practical method of prevention is to place on the freshly cut stump a substance which will either prevent F. annosus spores from germinating or will favor the development of fungi which are said to be antagonistic to F. annosus.

The two materials most often used are borax and urea. Borax prevents germination of F. annosus spores (3, 4, 7). Urea favors the development of fungi which are said to inhibit the development of F. annosus (2, 7).

Sodium nitrite, $NaNO_2$, a preventative substance used in Canada and England, works on the same principle as urea. The nitrogen stimulates saprophytic fungi with which F. annosus cannot compete (1).

Only one test had been conducted in the New England-New York area to determine which of eight preventive materials was most efficient (8). This test indicated borax was slightly more effective than urea. In light of present methods of evaluating stump treatments developed in the Southeast, this test seemed inadequate (3). Sodium Nitrite had not been previously evaluated in the United States.

A study to determine whether borax, urea or sodium nitrite was best suited for use in the New England-New York region was conducted during the summer of 1968.

OBJECTIVES

1. To determine if the recommendations made in the Forest Service Manual (5262) to prevent colonization of stumps by F. annosus with treatments of urea and/or borax are applicable in the Northeast.

2. To test the effectiveness of sodium nitrite, $NaNO_2$, in preventing colonization of red pine stumps by F. annosus.

STUDY DESIGN

Study Area

Three red pine plantations free from annosus root rot, but close to infection centers, were selected. They were located in Scituate, Rhode Island on the Providence Water Supply Board lands; Voluntown, Connecticut, on the Pachaug State Forest; and in Brattleboro, Vermont, on the Brattleboro Municipal Watershed. The three plantations were 35-45 years old. The soil in each was sandy. The areas had histories of agricultural use before being planted to pine.

Materials Used

Two pounds of 45% N urea were dissolved in a gallon of water to make a 20% solution by weight. No marker dye was added to the solution. Urea was applied to the stumps until the point of runoff with large plastic squeeze bottles commonly used for detergent.

Twenty Mule Team Fertilizer Borate 46 Coarse was applied as a powder. A dye was not added. One quart bleach containers were used to sprinkle the stumps with a light covering of borax.

The cost of urea and borax for treating stumps was determined by applying measured amount of the materials to stumps.

Sodium nitrite was applied as a 5% (W/V) solution. A dye was not added to the solution. This material was atomized onto stumps until the surface became moist. An atomizer was used as an applicator to accurately place the highly poisonous sodium nitrite. No attempt was made to determine the cost of treating stumps with sodium nitrite.

Treatment Application

In Rhode Island and Connecticut, 110 trees were cut in each plantation. Fifty were treated with urea and fifty with borax. Ten trees served as controls. One hour after the treatments had been applied, a mixture of chopped F. annosus conks and water was placed on all 110 stumps.

In Brattleboro, Vermont, 160 trees were cut. Fifty stumps were treated with urea, fifty with borax and fifty with sodium nitrite. Ten trees served as controls. All 160 stumps were treated with a conidial suspension (50,000/ml) of F. annosus within one hour of treatment application. Approximately 4 ml of this inoculum was applied to each stump.

All stumps were labelled with tags giving the location, stump number, date of treatment and treatment.

Treatment Analysis

Samples were collected from each stump approximately one month after treatment by removing three discs, each of which was about 1-2" in

thickness. The top disc was labelled A, the middle B and the bottom C. The residual stumps were retreated with borax. The discs were transported to the lab. The discs were immersed in 0.5% sodium hypochlorite and then rinsed in water. The discs were quartered and placed in clean plastic bags, one disc per bag. One core was removed from each of the quarters of the A discs with an increment hammer. The cores were placed on OPP media.

The quartered discs and cores were examined for F. annosus conidia under magnification 5-6 days after being collected.

The stumps were treated and samples collected at the three locations on the following dates:

Location	Treated	Collected
Rhode Island	July 2, 3, 8	Aug. 5, 6
Connecticut	July 9, 10, 11	Aug. 19, 20, 21
Vermont	July 16, 17, 18	Sept. 4, 5, 9

RESULTS

The results show conclusively that borax was the best material used for preventing F. annosus colonization of red pine stumps. Less than 1.5% of the stumps treated with borax were colonized by F. annosus (see Table 1). Borax proved to be significantly better than urea in preventing infection at all three test sites (Tables 2, 3, 4). Chi-square was used to test for independence between borax, urea and sodium nitrite and between borax and urea.

Urea was a better preventive material than sodium nitrite but it was not acceptable. About 9% of the urea treated stumps were colonized by F. annosus. Sodium nitrite proved to be almost worthless. Seventy percent of the stumps treated with sodium nitrite were colonized by F. annosus. Sixty percent of the control stumps were colonized by F. annosus.

One pound of borax could effectively cover 30 stumps with an average diameter of 8.4 inches. Thus, 2400 stumps can be treated with an 80 lb. bag. At a cost of $5.00 per bag, it costs 2/10 cents to treat a stump or approximately $1.25 per acre if 50% of the trees in a 6 x 6 spacing are removed.

One quart of 20% urea covered 14 stumps. A gallon, which contains 2 lbs of urea would thus cover 56 stumps. An 80 lb. bag would treat 2240 stumps. At $4.50 per bag, it costs 2/10 of a cent per stump or approximately $1.25 per acre.

DISCUSSION

Borax

Borax was the most effective preventive material. This finding agrees with information gathered in other parts of the country (6, 7, 8, 9). Borax was significantly better than urea, and sodium nitrite at the 0.5 percent level. Borax works by inhibiting the growth of the fungi. This was evidenced by the large number of sections where no fungal development was observed (Tables 2, 3, 4). Trichoderma species were rarely observed on the B and C discs. The most predominant group of fungi observed were blue stainers.

The toxic effect of borax does diminish with time and fungi other than F. annosus do colonize the stumps. Borax treated stumps do decompose within a few years unlike stumps treated with creosote.

The finer the powder used, the greater the number of stumps can be treated per pound. Borateem, which is a fine powder, covers more stumps per pound than fertilizer grade borax but it is also more expensive than the fertilizer grade. A dye does not need to be added to mark stumps treated with borax. The white powder stands out clearly. If the stumps are examined after a period of several months, a dye is helpful because the borax dissolves and cannot be seen after such an interval.

Urea

Urea was found to be unacceptable as a stump protectant as outlined by criteria established in the work plan. About 9% of the stumps treated with urea were infected. This is too high an infection rate to tolerate in plantations.

Fungi such as Trichoderma, Penicillium and blue stainers were greatly stimulated by urea (Tables 2, 3, 4). The stump tops were green with lush mold growth after one month. Trichoderma was also found on practically all bottom stump sections. This stimulation of fungi is said to be the reason why urea is supposed to be a good stump treatment. F. annosus is said to be a poor competitor against these fungi (2, 7). However, on all the stump sections where F. annosus was found, there were other fungi present, esp. Trichoderma. F. annosus conidia often could be found completely surrounded by Trichoderma. Evidently this mold was not an effective natural competitor of F. annosus. It is known that urea also stimulates Peniophora gigantea which is an effective competition of F. annosus. It was not isolated in this study.

Urea was messy to handle. It had to be weighed and the water had to be measured. This was required only once, however, because containers for both materials used were standardized. A dye should be added because the urea solution quickly becomes invisible. In the winter, antifreeze is added to the urea to prevent it from freezing. The mixing of water, urea, antifreeze and dye can become time consuming and sloppy.

Sodium nitrite

Sodium nitrite, as applied in Vermont, was completely unacceptable as a stump treatment. Seventy percent of the stumps treated with this material were infected with F. annosus.

There are two possible explanations for this high infection.

1. The 5% solution may have been too weak.

2. The technique of atomizing the material onto the stump may not have resulted in adequate coverage.

Sodium nitrite has to be mixed with water. A dye should be added, and in the winter antifreeze is needed. It becomes difficult to handle. It is also poisonous. Much of the thinning currently being done in the Northeast is on watersheds. Sodium nitrite can present difficulties in these areas. Prison labor is used for thinning some state plantations. Poison should be kept out of the hands of prisoners.

Sodium nitrite, like urea, stimulates the development of saprophytic fungi. Trichoderma was often observed on the bottom discs of the stumps treated with sodium nitrite and urea (Table 4). F. annosus was also found in these same bottom discs.

Controls

Sixty percent of the controls were infected by F. annosus. The infection was 100% on stumps inoculated with a conidial suspension. Only 40% of the stumps inoculated with chopped conks became infected.

The growth of molds on control stumps was not as rapid as on stumps treated with urea and sodium nitrite. While Trichoderma could be found on the bottom sections, the growth was not as lush as on urea and sodium nitrite treated stumps.

F. annosus grew much faster than anticipated. It was believed the fungus would only grow 2-3 inches in a month. It could often be found 6-7 inches below the stump surface.

It was interesting to note that F. annosus could sometimes be found in bottom sections but not in the top or in the cores. There are two possible explanations for this.

1. The conidia may have been overlooked on the top section or cores.

2. F. annosus may have grown out of the top and may have been replaced by saprophytes.

If this second theory is true, evaluation tests for stump treatments should be of short duration. Samples should be taken within

three months from the date of treatment. Placing split sections in plastic bags and incubating them for 5-6 days before examining them for F. annosus was more successful than examing increment cores. The two methods enhance each other, however.

The failure of ammonium fluoride in tests in the Southeast (3) and urea and sodium nitrite in the Northeast suggests the possibility that high nitrogen compounds in general are not effective stump protectants. This possibility should be investigated.

As stated by Sinclair (8), "Several criteria must be considered in the selection of a material for stump protection against F. annosus. The ideal material would incorporate the following features:

1. It must be very inexpensive to purchase and apply.

2. Low toxicity hazard to inexperienced woods personnel is essential.

3. It should be toxic or otherwise destructive to F. annosus, preferably selectively so.

4. It should rapidly kill at least the surface tissues of a stump, destroying selectivity for F. annosus and favoring later colonization by harmless forest saprophytes.

5. It should penetrate at least a few centimeters into the tracheids to allow eradication of recently established F. annosus colonies.

6. It should be easy to formulate and apply.

7. Protection should be absolute."

In this study borax met most, if not all, these requirements.

CONCLUSIONS

1. Borax is an effective stump treatment.

2. Urea was not an effective stump treatment in this study.

3. Sodium nitrite is not an effective stump treatment as applied in the Vermont study.

RECOMMENDATIONS

1. Borax should be the material used to prevent F. annosus colonization of stumps in the Northeast.

2. Sodium nitrite should not be used as a stump treatment in the Northeast.

More research is needed on the effectiveness of high nitrogen containing materials which are used to prevent colonization of stumps by F. annosus.

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Table 1.

Comparison of the effectiveness of borax, urea, and sodium nitrite in preventing colonization of stumps by Fomes annosus.

	Borax	Urea	Sodium Nitrite	Control	Total
Infected	2	13	35	18	68
Uninfected	148	137	15	12	312
Total	150	150	50	30	380

X^2 = 165.29 with 3 df, significant at the 0.5 percent level.

Comparison of the effectiveness of borax and urea in preventing colonization of stumps by Fomes annosus.

X^2 = 8.49 with 1 df, significant at the 0.5 percent level.

Table 2.

Comparison of the effectiveness of borax and urea in preventing colonization of stumps by Fomes annosus in Rhode Island.

		Infected by F. annosus	Other fungi	No growth
Urea				
Cores		3 (6)*	47 (94)	0
Disc	A	0	50 (100)	0
	B	0	48 (96)	2 (4)
	C	0	46 (92)	4 (8)
No. stumps with F. annosus			3 (6)	
Fifty stumps were treated.				
Borax				
Cores		0	36 (72)	14 (28)
Disc	A	0	41 (82)	9 (18)
	B	1 (2)	7 (14)	42 (84)
	C	0	13 (26)	37 (74)
No. stumps with F. annosus			1 (2)	
Fifty stumps were treated.				
Controls				
Cores		3 (30)	7 (70)	0
Disc	A	0	10 (100)	0
	B	0	10 (100)	0
	C	0	9 (90)	1 (10)
No. stumps with F. annosus			3 (30)	
Ten stumps served as controls.				

* Number in parenthesis refers to percent of stumps infected within the treatment.

Table 3.

Comparison of the effectiveness of borax and urea in preventing stump colonization by Fomes annosus in Connecticut.

Urea	Infected by F. annosus	Other fungi	No growth
Cores	1 (2)*	49 (98)	0 (0)
Disc A	0 (0)	50 (100)	0 (0)
B	0 (0)	49 (98)	1 (2)
C	0 (0)	45 (90)	5 (10)
No. stumps with F. annosus		1 (2)	
Fifty stumps were treated.			
Borax			
Cores	0 (0)	36 (72)	14 (28)
Disc A	0 (0)	39 (78)	11 (22)
B	0 (0)	46 (92)	4 (8)
C	0 (0)	43 (86)	7 (14)
No. stumps with F. annosus		0 (0)	
Fifty stumps were treated.			
Controls			
Cores	4 (40)	6 (60)	0 (0)
Disc A	3 (30)	7 (70)	0 (0)
B	1 (10)	7 (70)	2 (20)
C	0 (0)	8 (80)	2 (20)
No. stumps with F. annosus		5 (50)	
Ten stumps served as controls.			

* Number in parenthesis refers to percent of stumps infected within the treatment.

Table 4.

Comparison of the effectiveness of borax, urea and sodium nitrite in preventing colonization of stumps by Fomes annosus in Vermont.

	Infected by		
Urea	F. annosus	Other fungi	No growth
Cores	2 (4)*	48 (96)	0
Disc A	1 (2)	49 (98)	0
B	3 (6)	47 (94)	0
C	6 (12)	44 (88)	0
No. stumps with F. annosus	9 (18)		
Fifty stumps were treated with urea.			
Borax			
Cores	1 (2)	49 (98)	0
Disc A	1 (2)	47 (94)	2 (4)
B	0	32 (64)	18 (32)
C	0	23 (46)	27 (54)
No. stumps with F. annosus	1 (2)		
Fifty stumps were treated with borax.			
Sodium Nitrite			
Cores	4 (8)	46 (92)	0
Disc A	27 (54)	23 (46)	0
B	27 (54)	23 (46)	0
C	18 (36)	32 (64)	0
No. stumps with F. annosus	35 (70)		
Fifty stumps were treated with sodium nitrite.			
Controls			
Cores	10 (100)	0	0
Disc A	10 (100)	0	0
B	9 (90)	1 (10)	0
C	8 (80)	2 (20)	0
No. stumps with F. annosus	10		
Ten stumps served as controls.			

* Number in parenthesis refers to percent of stumps infested within the treatment.

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